

NDnano Undergraduate Research Fellowship (NURF) 2011 Project Summary

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Faculty mentor name: Professors Toni Barstis and Marya Lieberman

Project title: Constituent Analysis of Panadol via Paper Analytical Devices (PADs)

The World Health Organization defines a counterfeit medicine as a drug whose active ingredient is either underdosed or completely absent. It is projected that in developing countries up to 50% of the medications sold are counterfeits, which is attributed to a lack of testing equipment, trained individuals, and financial resources. The counterfeit pharmaceuticals include a large range of medications that include, but are not limited to, antimalarials, antibiotics, analgesics, antiretrovirals, antifungal, and antiparasitic medications.

This project focused on a commonly counterfeited medication, Panadol (Tylenol). Acetaminophen is the active ingredient in the over-the-counter drug Panadol, which is used worldwide to reduce fever and relieve pain. Acetaminophen may be replaced by cheaper white powders (such as chalk, talc, or gypsum) in counterfeit Panadol, and is used itself to replace the active ingredients in antimalarial drugs. For this research, I designed a Paper Analytical Device (PAD) to test for both active and inactive (e.g., binders/fillers) ingredients in Panadol, hereafter referred to as a Pandaol PAD. It is our goal to use a Panadol PAD to determine whether a Panadol pill is genuine or counterfeit.

My project involved several steps (see below). All the work was performed at Saint Mary's College, Notre Dame.

- (1) Fabricating PADs. A PAD is a paper-based device that has been modified to contain hydrophilic lanes surrounded by hydrophobic material. I developed a fabrication method that uses SU-8 2, a negative photoresist, as the hydrophobic material for the Panadol PAD. This method was modified by that published by George Whitesides.
- (2) Colorimetric chemistry. Extensive literature research was performed to identify select colorimetric indicators for each active and common ingredients found in genuine and counterfeit Panadol pills. Since most of the colorimetric chemistry published in the literature takes place in aqueous solution, these tests had to be adapted for paper. Once identified, the hydrophilic lanes of the PAD were loaded with specific volumes of these colorimetric indicators.
- (3) Creating a prototype. After several initial prototypes, I designed a final Panadol PAD prototype that contains a library of colorimetric tests that (a) qualitatively identifies both the active and common ingredients found in genuine and counterfeit Panadol pills and (b) semi-quantitatively measures the amount of acetaminophen, the active ingredient in genuine Panadol pills. It also contains information that the image analysis team deems necessary, including the QR code, color checker, and finder square.
- (4) Field-testing. To assess the reliability and usefulness of this final prototype, I conducted two field tests at the end of the summer: one by a group of fellow researchers (12) and



Figure 1: Diana Vega Pantoja and Prof. Toni Barstis in the laboratory at Saint Mary's College

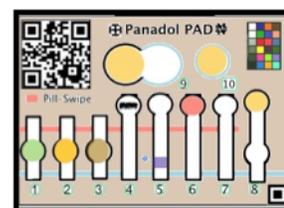


Figure 2 Prototype PAD



Figure 3 Field testing participants



one by a nonscience group of Saint Mary's and Notre Dame staff (12). I created pill samples that contained active ingredients found in genuine and counterfeit Panadol pills and put together a kit containing pill samples and PADs. People were instructed to swipe the pill in the designated area on the PAD and place it into a boat of water. After the colorimetric tests were complete, each participant interpreted the results and took a picture.

Presentation:

A 15-min oral presentation titled "Field Detection of Counterfeit Panadol and Tamiflu® using Paper Analytical Devices (PADs)" by Diana Vega Pantoja and Victoria Darling was delivered to COS-JAM at the University of Notre Dame in August 2011.

Publication:

Named on a provisional patent application, application number 61/515,235, on August 4, 2011.